[Name of Document] Specification

[Title of Invention] Cornerpieceless duct and a manufacturing method thereof

[Claims]

1. A cornerplate-less duct which has a tubular shape with a rectangular cross-section, the duct comprising:

a plurality of plate members joined to each other at side end portions thereof by seam joints, in which flange portions which are connecting faces adapted to connect adjacent ducts are formed integrally at a starting end portion and a terminal end portion of a plate formed into each plate member by bending the plate in a direction substantially perpendicular to a longitudinal direction of the plate, corner forming portions are formed to protrude outward from side ends of the flange portions in a width direction of the plate, and the corner forming portions of adjacent plate members are overlapped with each other to form corner portions of the flange portions of the duct in an assembled state;

wherein the plate is structured in expanded shape such that a first cut portion is formed in a portion which is closer to a center in the longitudinal direction of the plate than a starting end or a terminal end of the plate such that the first cut portion extends in the width direction of the plate and has a depth substantially equal to an overlapping portion of the corner portion.

2. The cornerplate-less duct according to claim 1, wherein in expanded shape of the plate, a dimension in a width direction of a portion of the plate which is closer to the center than the first cut portion is substantially equal to a sum of a dimension of a wall forming portion of the duct and a dimension of seam forming portions on both sides of the wall forming portion, and a dimension in a width direction of a portion of the plate which is closer to the starting end or the terminal end than the first cut portion is substantially equal to a sum of a dimension in a width direction of a flange forming portion formed into the flange portion and a protruding dimension of the corner forming portions.

3. The cornerplate-less duct according to claim 1 or claim 2, wherein the protruding dimension of the corner forming portions is substantially equal to a width of the connecting faces of the flange portions of the adjacent plate members in an assembled

state of the duct.

4. The cornerplate-less duct according to any one of claims 1 to 3, wherein the corner forming portions of plates are provided with fixing holes at a location where the corner portions of adjacent plate members overlap with each other to allow the fixing holes to conform to each other in an assembled state of the duct.

5. The cornerplate-less duct according to claim 4, wherein an engagement portion which is bendable is provided integrally with the fixing hole.

6. The cornerplate-less duct according to any one of claims 1 to 5, wherein the plate has a second cut portion which is closer to the center in the longitudinal direction than the first cut portion.

7. A method of manufacturing a cornerplate-less duct according to claim 1, comprising:

(a) temporarily bending the corner forming portion of the plate in expanded state by a predetermined angle in an opposite direction to bending of a seam forming portion located closer to the center than the first cut portion;

(b) forming the seam joint portion at a seam forming portion using a seam forming apparatus;

(c) returning the temporarily bent corner forming portion to an original state after the seam joint portion has been formed; and

(d) processing the starting end portion or the terminal end portion in the longitudinal direction of the plate using a seam forming apparatus, thereby forming the flange portions of the duct and the corner forming portions protruding laterally from the flange portions.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention relates to a cornerplate-less duct which is a duct used for air-conditioning, ventilation, or smoke emission in the case of fire, which is one type of

construction equipment, and a method of manufacturing the duct.

[0002]

[Related Art and Problems to be Solved by the Invention]

With regard to a traditional duct for air-conditioning or ventilation, which has been conventionally employed for more than 100 years, one of the inventors of the present invention has proposed, a novel duct which can be assembled without generation of a noise, stored and transported with significantly increased efficiency, and can be suspended easily and at a free position, and a suspending member that suspends the duct from a ceiling or the like (see Patent document 1, Patent document 2).

[0003]

The novel duct and the suspending member attract attention from duct industries overseas including those of U.S. and Europe because of the above described features, as well as Japan.

[0004]

One of the inventors made an innovative invention which can eliminate corner plates (corner members) which have been essential members in the prior art, by providing corner forming portions in corner portions of starting end and terminal end portions of the duct integrally with four plate members which are assembled by "seam joints" to form the duct having rectangular cross-section (see Patent document 3).

[0005]

However, the corner forming portions are formed by another members and these members are integrally spot-welded to the plate members with these members positioned to protrude from end portions of the flange forming portions of the plate members. This construction reduces the number of assembly steps but significantly increases the number of parts and the number of producing steps.

[0006]

Four plates (material in an expanded state before a forming process) forming the duct by joining seat joint portions at both ends are cut from a roll-shaped metal plate by a plasma cutter or the like. In a current manufacturing method, both end portions (corner portions) at a starting end portion and a terminal end portion of the plate are cut into scraps because they obstruct placement of the corner plates (corner members).

[0007]

The present invention has been made under the circumstances. Attention has been focused on scraps which have been traditionally discarded. An object of the present invention is to provide a cornerplate-less duct having a rational construction, which enables the number of parts and forming steps to be significantly reduced by effectively utilizing the scraps, and enables a shape of an assembled duct to be maintained, and a duct manufacturing method thereof.

[0008]

[Patent Document 1] Japanese Unexamined Patent Application Publication No. 10-47741

[Patent Document 2] International Publication No. WO01/84058

[Patent Document 3] Japanese Laid-Open Patent Application Publication No. 2001-355906

[0009]

[Means for Solving the Problems]

A cornerplate-less duct which has a tubular shape with a rectangular cross-section, according to claim 1 and a first invention, comprises a plurality of plate members joined to each other at side end portions thereof by seam joints, in which flange portions which are connecting faces adapted to connect adjacent ducts are formed integrally at a starting end portion and a terminal end portion of a plate formed into each plate member by bending the plate in a direction substantially perpendicular to a longitudinal direction of the plate, corner forming portions are formed to protrude outward from side ends of the flange portions in a width direction of the plate, and the corner forming portions of adjacent plate members are overlapped with each other to form corner portions of the flange portions of the duct in an assembled state; wherein the plate is structured in a expanded shape such that a first cut portion is formed in a portion which is closer to a center in the longitudinal direction of the plate than a starting end or a terminal end of the plate such that the first cut portion extends in the width direction of the plate and has a depth substantially equal to an overlapping portion of the corner portion.

[0010]

In accordance with the cornerplate-less duct according to the first invention constructed above, it is possible to produce the plate member having the seam joint

portion formed at a location which is closer to the center than the first cut portion in the longitudinal direction on both sides of the plate, the flange portion and the corner portions on both sides of the flange portion which are formed at a location closer to the starting end or the terminal end than the first cut portion, by the manufacturing method according to the second invention.

By joining the seam joint portions at both side ends of the plate member to the seam joint portions of another plate member, i.e., by joining the seam joint portions at both ends of four plate members, the duct having the rectangular cross-section is assembled. The flange portion which becomes a connecting portion between ducts is formed at the starting end portion or the terminal end portion of the duct, and the corner forming portions are formed to protrude from both side ends of the flange portion and become the corner portions of the duct by overlapping with the corner portion of its adjacent plate member in a plate thickness direction.

[0011]

In assembling of the duct, corner plates, i.e., another members for joining the corner portions of adjacent plate members, which have been conventionally prepared, for example, by spot welding, may be omitted. In addition, an attaching process for attaching the corner plates to the plate members to protrude from the flange portion may be omitted.

[0012]

As s result, it is not necessary to manufacture and store the corner plates, and to attach the corner plates to the plate members. Thus, the duct with a rectangular cross-section, which has the corner portions is constructed very simply. In addition, since the both side end portions of the starting end portion or the terminal end portion which have been cut away and discarded are effectively utilized to form the corner forming portions (corner portions), the plate members are produced from the metal plate without wastes.

[0013]

Further, since the corner portions are integral with the plate member, labor and time required for attaching the corner plates become unnecessary, and even a non-skilled person can assemble the duct quickly and easily.

[0014]

It is preferable that in the cornerplate-less duct, in the expanded shape of the plate, a dimension in a width direction of a portion of the plate which is closer to the center than the first cut portion is substantially equal to a sum of a dimension of a wall forming portion of the duct and a dimension of seam forming portions on both sides of the wall forming portion, and a dimension in a width direction of a portion of the plate which is closer to the starting end or the terminal end than the first cut portion is substantially equal to a sum of a dimension in a width direction of a flange forming portion formed into the flange portion and a protruding dimension of the corner forming portions.

[0015]

Also, it is preferable that, in the cornerplate-less duct, the protruding dimension of the corner forming portions is substantially equal to a width of the connecting faces of the flange portions of the adjacent plate members in an assembled state of the duct.

[0016]

Also, it is preferable that in the cornerplate-less duct, the corner forming portions of plates are provided with fixing holes at a location where the corner portions of adjacent plate members overlap with each other to allow the fixing holes to conform to each other in an assembled state of the duct. Since the fixing holes serve as a guide for assembling the plate members to be joined to each other, the duct can be precisely assembled into a predetermined shape.

[0017]

An engagement portion which is bendable may be provided integrally with the fixing hole. The engagement portion is inserted into the opposite fixing hole and is bent in an assembled state so that the adjacent plate members engage with each other, i.e., the assembled state is maintained.

[0018]

In the cornerplate-less duct, the plate may have a second cut portion which is closer to the center in the longitudinal direction than the first cut portion. When the flange forming portion is formed into the flange portion by the apparatus, a portion between the second cut portion and the first cut portion is held between the rollers of the apparatus, so that the flange portion is processed easily.

[0019]

A method of manufacturing a cornerplate-less duct according to a second invention, for manufacturing the cornerplate-less duct of the first invention, comprises: (a) temporarily bending the corner forming portion of the plate by a predetermined angle in an opposite direction to bending of a seam forming portion located closer to the center than the first cut portion; (b) forming the seam joint portion at a seam forming portion using a seam forming apparatus; (c) returning the temporarily bent corner forming portion to an original state after the seam joint portion has been formed; and (d) processing the starting end portion or the terminal end portion in the longitudinal direction of the plate using a seam forming apparatus, thereby forming the flange portions of the duct and the corner forming portions protruding laterally from the flange portions.

[0020]

In accordance with the duct manufacturing method comprising the above mentioned steps, it is possible to form the plate member having the seam joint portion at the portion closer to the center than the first cut portion in the longitudinal direction, the flange portion formed closer to the starting end or the terminal end than the first cut portion and the corner portions formed integrally on both sides of the flange portion.

[0021]

[Embodiment of the Invention]

Hereinafter, embodiments of a cornerplate-less duct of the present invention will be described with reference to the drawings. Also, a method of manufacturing the duct will be described.

[0022]

A cornerplate-less duct (hereinafter also referred to as a duct) according to an embodiment of the present invention will be described.

[0023]

Fig. 1 is a view showing a shape of a plate before a forming process, corresponding to a plate member having male seam joint portions at side end portions thereof, which is one of adjacent plate members forming a duct. Likewise, Fig. 2 is a view showing a shape of plate having female seam joint portions at side end portions thereof.

[0024]

A plate 1A having male seam forming portions 7m at side end portions for forming male seam joint portions 17m (see Fig. 6) is, as shown in an expanded shape shown in a plan view of Fig. 1, provided with cut portions (first cut portions) 2A at locations which are spaced apart from a starting end 1s and a terminal end 1e in a longitudinal direction (see an arrow Za in Fig. 1) of the plate 1A so as to be closer to a center (center in a vertical direction of Fig. 1) such that the cut portions 2A extend in a width direction (see an arrow Ya in Fig. 1) of the duct 1A. It will be appreciated that, although the starting end 1s and the terminal end 1e are not physical ends of the plate 1A of the embodiment having a folded portion 14b (see Fig. 6), ends of the plate member excluding the folded portion 14b (see Fig. 6) are called the starting end 1s and the terminal end 1e of the plate member, for the sake of convenience, because the folded portion (see Fig. 6B) is not necessarily an essential portion.

In addition, second cut portions 22 are formed at locations closer to the center in the longitudinal direction than the first cut portions 2A. The dimension from the first cut portion 2A to the second cut portion 22 is set to a dimension for allowing the plate 1A to be retained by a roller of a forming machine when a flange forming portion 3 is formed into a flange portion 13 (see Fig. 6), or set larger than that dimension. Specifically, the dimension is preferably 3cm to 6cm. As shown in Figs. 8 and 9, a portion G from the first cut portion 2A to the second cut portion 22 is, after the flange portion 13 is formed, bent toward an opposite plate member 11B when assembled into the duct, and serves to close the corner portion of the duct 10. In addition, the portion G serves to fix an end portion of the seam joint portion.

[0025]

The plate 1B having female seam forming portions 7f forming female seam joint portions 17f (see Fig. 6) is, as shown in an expanded shape of Fig. 2, provided with cut portions (first cut portions) 2B at locations which are spaced apart from a starting end 1s and a terminal end 1e in a longitudinal direction (see an arrow Za in Fig. 2) of the plate 1B so as to be closer to a center such that the cut portions 2B extend in a width direction (see an arrow Ya in Fig. 2). In this embodiment, the longitudinal dimension of the cut portion 2B is smaller than the dimension from the starting end 1s (or terminal end 1e) of the plate 1A in Fig. 1 to the second cut portion 22. However, the longitudinal dimension of the cut portion 2B may be equal to or larger than the dimension from the

starting end 1s (or terminal end 1e) of the plate 1A to the second cut portion 22 (to be precise, the dimension from the starting end 1s (or terminal end 1e) to an end portion 22e on the centre side of the second cut portion 22). The position (dimension) of the cut portion 2B on the starting end 1s side (or terminal end 1e side) from the starting end 1s (or terminal end 1e) is set equal to the position (dimension) of the first cut portion 2A on the starting end 1s side (or terminal end 1e side) from the starting end 1s (or terminal end 1e). The end of the cut portion 2B on the center side in the longitudinal direction (Za direction of Fig. 2) is located closer to the center in the longitudinal direction than the end of the first cut portion 2A on the starting end 1s side (or on the terminal end 1e side).

[0026]

The depth (dimension) d of each of the cut portions 2A and 2B is substantially equal to an overlapping portion W1 (see Fig. 6) of a corner forming portion 4. In other words, the dimension of the depth d is equal to a width v of the flange portion 13 of each of the processed plates 1A and 1B. The plates 1A and 1B have the cut portions 2 with an equal depth d.

[0027]

In expanded shapes of the plates 1A and 1B, a dimension W2 in a width direction of a portion which is closer to the center in the longitudinal direction than the cut portions 2A and 2B is the sum of a dimension W3 of a wall forming portion 8 which becomes a wall 18 (see Fig. 10) of the duct 10 and dimensions W4 of seam forming portions 7(7m, 7f) formed on both side ends (both ends in the width direction of the plates 1A and 1B), with the plates 1A and 1B assembled into the duct 10 (see Fig. 10).

The plate 1A having the male seam forming portions 7m differs from in the dimension W2 in the width direction from the plate 1B having the female seam forming portions 7f due to the difference in the dimension W4 in the width direction of the seam forming portions 7m and 7f. Specifically, a dimension W2m of the plate 1A having the male seam forming portions 7m is smaller than a dimension W2f of the plate 1B having the female seam forming portions 7f. This dimensional difference is, as shown in Fig. 6, caused by the fact that the male seam joint portion 17m is formed merely by bending the male seam forming portions 7m (see Fig. 1) substantially 90 degrees, while the female seam joint portion 17f is formed by bending the female seam forming portions 7f (see Fig. 2) plural times (three times in the first embodiment).

[0028]

While the duct 10 of this embodiment is structured such that the width W and the height H are equal (i.e., the duct 10 has a square cross-section) as shown in Fig. 10, there is a difference in the dimension W3 of the wall forming portion 8 between the plates 1A and 1B in the case of a duct having a width and a height which are different from each other, as a matter of course.

[0029]

As shown in Figs. 1 and 2, in the planar shapes of the plates 1A and 1B, a dimension W5 in the width direction of portions (flange forming portions 3) which are closer to the ends (starting end 1s and terminal end 1e) in the longitudinal direction than the cut portions 2A and 2B is equal to the dimension W3. A dimension L1 in the longitudinal direction of these portions (flange forming portions 3) is a sum of a dimension L1a and a dimension L1b. The dimension L1a becomes a width va of joint faces 13a of the flange portion 13 (see Fig. 6). And, the dimension L1b becomes a width vb of the folded portion 13b of the flange portion 13.

The flange forming portions 3 are each formed by a region having the dimension W5 and the dimension L1. Following the flange forming portions 3, corner forming portions 4 (see Figs. 1 and 2) protrude in the width direction (arrow Ya direction in Figs. 1 and 2) in the width direction of the plates 1a and 1B to form the corner portions 14 of the duct 10 shown in Fig. 10. A dimension L2 in the longitudinal (arrow Za direction of Figs.1 and 2) of the corner forming portions 4 is equal to a dimension L1 in the longitudinal direction of the flange forming portions 3. The dimension L2 in the longitudinal direction is a sum of a dimension L2a and a dimension L2b. The dimension L2a becomes an overlapping portion 14a (see Fig. 6) of the corner portion 14 (see Fig. 6) and the dimension L2b becomes the folded portion 14a (see Fig. 6) of the corner portion 1.

A dimension W6 in the width direction of the corner portions 14 is substantially equal to the dimension L2a in the longitudinal direction. Also, the dimension W6 in the width direction is equal to the overlapping portion W1 (see Fig. 6) of the corner portion 14.

[0030]

The plates 1A and 1B having the planar shapes shown in Fig. 1 or Fig. 2 are cut

out from metal thin plates generally supplied as roll materials by a plasma processor (plasma cutter). Alternatively, as a matter of course, the plates 1A and 1B may be cut out manually by an operator using other cutters or "tin scissors".

[0031]

In contrast to the conventional plate, the plates 1A and 1B having the above-described planar shapes are structured such that the corner forming portions 4 are integral with and protrude from the flange forming portions 3 in the width direction of the plates 1A and 1B. In other words, portions (see hatched portions represented by N in Figs. 1 and 2) which have been conventionally cut out as being discarded can be used as the corner forming portions 4.

[0032]

The plate 1A (or 1B) having the above described planar shape becomes a plate member to be assembled into the duct 10 through steps described below.

With reference to Fig. 3 which illustrates the plate 1A along manufacturing steps (forming process), the corner forming portions 4 located at four corners (the corner forming portions 4 and their adjacent portions G in the case of the plates 1A) which are shown in Fig. 3(a), are temporarily bent a predetermined angle in the opposite direction to the bending of the seam forming portions 7 (7m, 7f), i.e., as indicated by an arrow r of Fig. 3(b). Specifically, the corner forming portions 4 are temporarily bent at an angle approximately 30 degrees or more (approximately 45 degrees) (see Fig. 3(b) which illustrates the plate 1A after temporal forming process). The corner forming portions 4 are temporarily bent so as not to interfere with seam forming regions.

The corner forming portions 4 may be temporarily bent manually using an instrument tool by an operator, or automatically by a temporal forming machine installed continuously with the seam forming machine. Alternatively, this may be done using a seam forming machine shown in Fig. 50.

Subsequently, the temporarily formed plate 1A (or 1B) is, as shown in Fig. 3(c), formed by the seam forming apparatus in such a manner that the seam forming portion 7 (7m or 7f) which is one side end portion (left side end portion in Fig. 3) of the plate 1A (or 1B) is formed into a seam joint portion and then, the seam forming portion 7 (7m or 7f) which is an opposite side end portion (right end portion in Fig. 3) is, as shown in Fig. 3(d), formed into a seam joint portion. Through this process, the seam joint portions

(17m, 17f) are formed on both sides of the plate members 11A and 11B. The seam joint portions, to be specific, the male seam joint portions are formed through steps shown in Figs. 4(a) to 4(e) and the female seam joint portions are formed through steps shown in Figs. 5(a) to 5(j). In this embodiment, as shown in Figs. 4 and 5, the corner forming portions 4 (and the adjacent portions G in the case of the plate 1A) are desirably temporarily bent again to form 90 degrees so as not to interfere with the seam forming regions (see Figs. 4 and 5).

After the seam joint portions 17 (specifically, the male seam joint portions 17m in the case of the plate member 11A and the female seam joint portion 17f in the case of the plate member 11B as shown in Fig. 6) have been formed from the seam forming portions 7 (7m, 7f), the temporarily bent corner forming portions 4 (and the adjacent portions G in the case of the plate 1A) are returned to their original states, that is, made substantially flush with the flange forming portions 3 (see Fig. 3(e), and two-dotted lines and an arrow q indicating a return direction in Figs. 4(e) and 5(j)).

[0033]

The corner forming portions 4 may be returned to be substantially flush with the flange forming portions 3 manually or using an instrument tool by an operator, or automatically by a temporal forming machine installed continuous with the seam forming machine.

[0034]

Subsequently, as shown in Fig. 3(f) or 3(g), the flange forming portion 3 provided at the starting end 1s (or terminal end 1e) of the plate 1A (or 1B) is formed into the flange portion 13 (see Fig. 6). Through this process, the corner forming portion 4 is formed into the corner portion 14 which is formed integrally with the flange portion 13 to protrude from both sides thereof.

The flange forming portion 3 can be formed into the flange portion 13 using a forming machine basically having the same construction as that of the forming machine generally used to form the seam joint portion, more specifically, a forming machine equipped with a plurality of forming rollers.

[0035]

A procedure for assembling the cornerplate-less duct using the plate member 11A having the male seam joint portions 17m and the plate member 11B having the

female seam joint portions 17f, and the cornerplate-less duct will be described below.

[0036]

As shown in Fig. 6 or 7, four, i.e., two pairs of plate members 11A and 11B are assembled in the duct 10 shown in Fig. 10 in such a manner that the male seam joint portion 17m of each of the plate members 11A is inserted into a seam groove 17g of the female seam joint portion 17f of each of the plate members 11B (see arrow Q of Figs. 6 and 7). In this case, the portion G is bent in the direction in which the male seam joint portion 17m is bent. In this embodiment, since a center-side end of the portion G in the longitudinal direction is closer to the center than a center-side end of the cut portion 2B, a center-side end portion of the portion G covers the seam joint portion to fix the seam joint portion (see Fig. 8).

While the portion G is bent manually by the operator using a tool, it may be bent using a machine as a matter of course.

In the structure of the seam joint, as shown in Figs. 8 and 9, the corner portions 14 of the adjacent plate members 11A and 11B overlap with each other in a plate thickness direction, thus forming the corner portion 14 of the duct 10.

By forming holes 9 in the corner portions 14 of the plate members 11A and 11B to allow these holes 9 to conform to each other with the plate members 11A and 11B assembled into the duct 10, positioning of the plate members 11A and 11B is facilitated, and precise positioning is confirmed.

In addition, the holes 9 for fixing serve as holes through which joint bolts (not shown) are inserted when the ducts 10 (see Figs. 16) are joined. The corner portions 14 joined by the joint bolts are made rigid.

[0037]

Instead of the fixing holes 9 which are circular, rectangular holes 9 shown in Fig. 16 may be used or holes having other shapes may be used.

When the fixing holes 9 are formed, an engagement portion 9A may be formed within at least one of the holes 9 as shown in Fig. 17, and the engagement portion 9A is inserted through an opposite hole 9 and bent toward the back side of the plate member 11A to allow the adjacent plate members 11a and 11B to be fixed as shown in Figs. 18(a) and 18(b). Alternatively, the engagement portion 9A may be formed at a different location of the rectangular hole 9, for example, at a side portion or an upper portion. In

particular, by providing the engagement portion 9A at the upper portion of the rectangular hole 9, the plate 1A can be engaged in an opposite direction to a direction of engagement of the seam joint portion, the duct 10 can be held in a predetermined state.

In addition, by engaging the plate members 11A and 11B in the hole 9 by the engagement portion 9A, the duct 10 can be held in the predetermined state (tubular shape state), and hence operation becomes easier when the duct 10 assembled in Figs. 10 and 15 is fed or suspended at a predetermined location, or the ducts 10 are joined.

In an alternative embodiment of the engagement portion 9A, as shown in Figs. 19(a) and 19(b), the engagement portion 9A may be formed on each of upper and lower sides of the hole 9 to enable engagement between the plate members 11A and 11B by the upper and lower sides of the hole 9. In such a structure, the plate members 11A and 11B can be vertically fixed. In a further alternative, as shown in Figs. 20(a) to (d), engagement portions 9A of various shapes may be formed on the hole 9. Instead of the engagement portion 9A in the embodiments of Figs. 20(a) and 20(b), a circular engagement portion 9A capable of engaging the plate members 11A and 11B entirely in a circumferential direction of the hole 9, or an engagement portion 9A provided with a triangular portion, which is capable of engagement between the plate members 11A and 11B in upward and downward directions and in rightward and leftward directions.

[0038]

While description has been given of the duct assembled by the plate members having the seam joint structure of button punch type, the cornerplate-less duct of the present invention is not limited to have the seam joint structure of the button punch type, but may be applied to a duct assembled by plate members 11A and 11B having Pittsburgh type seam joint structures shown in Figs. 11 and 12, as a matter of course. The plate members 11A and 11B having the Pittsburgh type seam joint structures can be manufactured through steps in Fig. 13 which illustrates forming steps of the male seam joint portion and in Fig. 14 which illustrates forming steps of the female seam joint portion, i.e., through substantially the same steps as those through which the plate members having the button punch type seam joint portions.

As in the duct having the above mentioned seam joint structure, in the duct 10 assembled by the Pittsburgh type seam joint structure, the corner portions 14 of the duct 10 are formed by overlapping the corner portions 14 of the plate members 11A and 11B

in the plate thickness direction as shown in Fig. 15, and thus, a cornerplate-less duct is formed.

In Figs. 11 through 15, the same reference designators as those in Figs. 1 through 10 denote the same or corresponding components.

[0039]

While the description has been given of the duct structured such that the female seam joint portion is exposed to an outer wall side of the duct 10 in this embodiment, the cornerplate-less duct of the present invention may be applicable to a duct provided with a female seam joint portion on an inner wall side thereof (conventionally used duct). Specifically, this may be accomplished by bending the flange portion 13 of the plate member 11B provided with female seam joint portions 17f on both sides (only one side is shown in Fig. 21) in the opposite direction to an inner wall 18i of the duct 10.

[Industrial Applicability]

In accordance with the cornerplate-less duct of the present invention, it is possible to attain a duct which are formed by fewer components, and are manufactured at significantly reduced assembly steps.

[0040]

In accordance with a method of manufacturing the cornerplate-less duct of the present invention, the cornerplate-less duct can be manufactured efficiently and using the apparatus.

[0041]

[Effects of the Invention]

In accordance with a method of manufacturing the cornerplate-less duct of the present invention, the cornerplate-less duct can be manufactured efficiently and using the apparatus.

[0042]

Also, in accordance with a method of manufacturing the cornerplate-less duct of the present invention, the cornerplate-less duct can be manufactured efficiently and using the apparatus.

[Brief Description of the Drawings]

Fig. 1 is a view showing an expanded shape of a plate having male seam forming portions at side end portions thereof, in plate members disposed adjacent to each

other and constituting a duct;

Fig. 2 is a developed view showing an expanded shape of a plate having female seam forming portions at side end portions thereof, in plate members disposed adjacent to each other and constituting a duct;

Figs. 3(a) to 3(g) are perspective views showing a procedure of a forming process of seam forming portions and flange forming portions of the plates in Figs. 1 and 2;

Figs. 4(a) to 4(e) are cross-sectional views of a plate member as seen in a direction substantially perpendicular to the longitudinal direction of the plate, showing a procedure for forming the male seam forming portion of Figs. 3(a) to 3(g);

Figs. 5(a) to 5(j) are cross-sectional views of the plate as seen in a direction substantially perpendicular to the longitudinal direction of the plate, showing a procedure for forming the female seam forming portion of Figs. 3(a) to 3(g);

Fig. 6 is a perspective view showing a state before plate members manufactured through the forming process of Figs. 3, 4, and 5 are joined to each other;

Fig. 7 is a perspective view of the state before the plate members are joined to each other, as seen from a perspective different from that of Fig. 6;

Fig. 8 is a perspective view showing a state of a corner portion and a seam joint portion of the duct, in which the plate members of Fig. 6 or Fig. 7 have been assembled;

Fig. 9 is a perspective view showing a state in which seam joint portions have been joined to each other and assembled, as seen from a perspective different from that of Fig. 8;

Fig. 10 is a perspective view showing a schematic structure of one end portion of a cornerplate-less duct;

Fig. 11 is a perspective view showing a structure of the plate members having Pittsburgh type seam joint portions in a state before being seam-joined;

Fig. 12 is a perspective view showing a state of a final assembly step for seam-joining the plate members of Fig. 11;

Figs. 13(a) to 13(e) are cross-sectional views of the plate as seen in a direction perpendicular to the longitudinal direction of the plate, showing a procedure for forming the male seam joint portion of the Pittsburgh type seam joint portion shown in Figs. 11 and 12;

Figs. 14(a) to 14(j) are cross-sectional views of the plate as seen in a direction perpendicular to the longitudinal direction of the plate, showing a procedure for forming the female seam joint portion of the Pittsburgh type seam joint portion shown in Figs. 11 and 12;

Fig. 15 is a perspective view showing a structure of one end portion of the duct assembled using the plate members having the Pittsburgh type seam joint portion shown in Figs. 11 and 12;

Fig. 16 is an enlarged perspective view of portions of adjacent plate members having fixing holes of a different shape, which become a corner portion of the duct;

Fig. 17 is a partially enlarged perspective view of the corner portion in which an engagement portion is provided integrally on a fixing hole;

Figs. 18(a) and 18(b) are views showing a state in which the plate members engage with each other by the fixing holes using the engagement portion, wherein Fig. 18(a) is a partially enlarged perspective view of the corner portion showing a state in which adjacent plate members engage with each other by the fixing holes using the engagement portions integrally provided on the fixing holes, and Fig. 18(b) is a cross-sectional view showing a structure surrounding the fixing holes in an engagement state of Fig. 18(a);

Figs. 19(a) and 19(b) are views showing a state in which the plate members engage with each other by fixing holes using engagement portions according to an embodiment different from that of Figs. 18(a) and 18(b), wherein Fig. 19(a) is a partially enlarged perspective view showing a state in which the adjacent plate members engage with each other by the fixing holes using the engagement portions integrally provided on the fixing holes, and Fig. 19(b) is a cross-sectional view showing a structure surrounding the fixing holes in an engagement state;

Figs. 20(a) to 20(d) are partially enlarged views showing engagement portions which are formed on the fixing holes and have various shapes, as seen from the direction perpendicular to the holes;

Fig. 21 is a perspective view showing an embodiment in which a cornerplate-less duct is applied to a duct structured such that the female seam joint portion of the seam joint portion is located on an inner wall side of the duct in an assembled state of the duct.

[Description of Reference Numerals]

10... duct

1A...plate member

1B...plate member

2... cut portion

W1...overlapping portion

X... longitudinal direction

Y... width direction

1s... starting end

1e...terminal end